

What is claimed is:

1. A laser-diode-pumped solid-state laser apparatus comprising:
  - a solid-state laser medium, which absorbs a pumping light to generate or amplify light of a predetermined wavelength;
  - a laser diode light source, which generates said pumping light and introduces the generated pumping light into the laser medium directly or via an optical device; and
  - 10 a fluorescence detection unit for detecting a quantity of fluorescence generated from the solid-state laser medium at a position inside a laser resonator composing the solid-state laser apparatus, the position being near an optical axis of a laser oscillation light generated in the resonator and not blocking the optical axis.
2. The laser-diode-pumped solid-state laser apparatus according to Claim 1, wherein said pumping light is introduced from a direction approximately perpendicular to the optical axis of said laser oscillation light.
3. The laser-diode-pumped solid-state laser apparatus according to Claim 1, wherein said fluorescence detection unit comprises: optical unit disposed in a position near said optical axis of the laser oscillation light and not blocking the optical axis; and a photo-detector that detects said fluorescence introduced by said optical unit.
4. The laser-diode-pumped solid-state laser

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apparatus according to Claim 3, wherein

    said optical unit includes a mirror for reflecting  
    said fluorescence emitted from the solid-state laser medium,  
    and said fluorescence reflected by the mirror propagates in  
5     space and is made incident into said photo-detector disposed  
    in a predetermined position.

5. The laser-diode-pumped solid-state laser  
apparatus according to Claim 4, wherein

    said mirror is formed in a parabolic shape, and said  
10    fluorescence reflected by the mirror propagates in space and  
    focuses on said photo-detector.

6. The laser-diode-pumped solid-state laser  
apparatus according to Claim 3, wherein

    said optical unit comprises a transparent medium in  
15    the wavelength of said fluorescence, and said fluorescence  
    made incident from one end of the medium propagates through  
    the medium and is made incident into said photo-detector  
    disposed at the other end.

7. The laser-diode-pumped solid-state laser  
20    apparatus according to Claim 6, wherein

    said optical unit is formed so as to surround a  
    periphery of an optical axis in a part of the optical path  
    of said laser oscillation light, and said fluorescence made  
25    incident from an end portion of an opening provided in said  
    optical unit is guided into said photo-detector disposed in  
    a predetermined position on an end portion of an outer  
    periphery.

8. The laser-diode-pumped solid-state laser

apparatus according to Claim 7, wherein

    said optical unit forms any of a disc shape, a  
    polygonal shape and an elliptic shape.

9. The laser-diode-pumped solid-state laser

5 apparatus according to Claim 8, wherein

    the center of said opening is arranged at a first  
    focal point of said elliptic shape, and said photo-detector  
    is arranged at a second focal point.

10. The laser-diode-pumped solid-state laser

10 apparatus according to Claim 7, comprising:

    reflection unit for reflecting said fluorescence in a  
    region of an outer periphery of said optical unit except for  
    the vicinity of said photo-detector, wherein

15     said fluorescence made incident from the end portion  
    of said opening is reflected by said reflection unit and  
    guided into said photo-detector.

11. The laser-diode-pumped solid-state laser

apparatus according to Claim 7, wherein

20     a plurality of said photo-detectors are disposed all  
    around the outer periphery of said optical unit, and  
    any of an axial symmetry of said laser beam and  
    degradation of said laser diode light source is identified  
    by comparing output from a plurality of the photo-detectors.

12. The laser-diode-pumped solid-state laser

25 apparatus according to Claim 7, wherein

    the diameter of said opening is set smaller than the  
    diameter of said laser medium.

13. The laser-diode-pumped solid-state laser

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apparatus according to Claim 6, wherein

    said transparent medium is made up of glass as a  
parent material.

14. The laser-diode-pumped solid-state laser

5 apparatus according to Claim 6, wherein

    said transparent medium is made up of any of a  
material that selectively attenuates light having the  
wavelength of said pumping light and a material that  
selectively transmits a wavelength of a fluorescence  
10 emission line spectrum that is not used in laser oscillation.

15. The laser-diode-pumped solid-state laser

apparatus according to Claim 1, further comprising:

    a filter selectively attenuates light having the  
wavelength of said pumping light on the optical path of said  
15 fluorescence reaching said photo-detector.

16. The laser-diode-pumped solid-state laser

apparatus according to Claim 1, further comprising:

    a filter selectively transmits a wavelength of a  
fluorescence emission line spectrum that is not used in  
20 laser oscillation out of said fluorescence emitted from said  
solid-state laser medium, on the optical path of said  
fluorescence reaching said photo-detector.

17. The laser-diode-pumped solid-state laser

apparatus according to Claim 1, wherein

25       said laser diode light source includes: a plurality  
of laser diode devices; a power source that drives a  
plurality of said laser diode devices in a predetermined  
number of groups; and controller for controlling the drive

current of said power source, wherein said controller adjusts the drive current for each of said groups in accordance with the intensity of said fluorescence detected by said photo-detector.

- 5        18. A status diagnostic method of a laser-diode-pumped solid-state laser apparatus having: a solid-state laser medium, which absorbs a pumping light to generate or amplify beam of a predetermined wavelength; a laser diode light source, which generates said pumping light and
- 10      introduces the generated pumping light into the laser medium directly or via an optical device; and a fluorescence detection unit provided at a position in a laser resonator, which composes the solid-state laser apparatus, near an optical axis of a laser oscillation light generated in the
- 15      resonator and not blocking the optical axis,

          said status diagnostic method comprising the steps of:

          detecting a quantity of the fluorescence generated from the solid-state laser medium by said fluorescence

- 20      detection unit; and

          comparing said quantity of the fluorescence with any one of a predetermined value and a previously measured value to diagnose degradation status of said laser diode light source.

- 25      19. The status diagnostic method of a laser-diode-pumped solid-state laser apparatus according to Claim 18, wherein

          said fluorescence detection unit comprises: optical

unit disposed in a position near said optical axis of the laser oscillation light and not blocking the optical axis; and a photo-detector that detects said fluorescence introduced by said optical unit.

5        20. The status diagnostic method of a laser-diode-pumped solid-state laser apparatus according to Claim 18  
wherein

10      said optical unit includes a mirror for reflecting  
said fluorescence emitted from the solid-state laser medium,  
and said fluorescence reflected by the mirror is propagated  
in space and is made incident into said photo-detector  
disposed in a predetermined position.

15      21. The status diagnostic method of a laser-diode-pumped solid-state laser apparatus according to Claim 20,  
wherein

      said mirror is formed in a parabolic shape, and said  
fluorescence reflected by the mirror is propagated in space  
and focused on said photo-detector.

20      22. The status diagnostic method of a laser-diode-pumped solid-state laser apparatus according to Claim 18,  
wherein

25      said optical unit comprises a transparent medium in  
the wavelength of said fluorescence, and said fluorescence  
made incident from one end of the medium is propagated  
through the medium and made incident into said photo-  
detector disposed at the other end.

      23. The status diagnostic method of a laser-diode-pumped solid-state laser apparatus according to Claim 22,

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wherein

said optical unit is formed so as to surround a periphery of an optical axis in a part of the optical path of said laser oscillation light, and said fluorescence made 5 incident from an end portion of an opening provided in said optical unit is guided into said photo-detector disposed in a predetermined position on an end portion of an outer periphery.

24. The status diagnostic method of a laser-diode-  
10 pumped solid-state laser apparatus according to Claim 23,  
wherein

said optical unit forms any of a disc shape, a polygonal shape and an elliptic shape.

25. The status diagnostic method of a laser-diode-  
15 pumped solid-state laser apparatus according to Claim 24,  
wherein

the center of said opening is arranged at a first focal point of said elliptic shape, and said photo-detector is arranged at a second focal point.

26. The status diagnostic method of a laser-diode-  
pumped solid-state laser apparatus according to any one of  
Claims 23, wherein

reflection unit for reflecting said fluorescence is included in a region of an outer periphery of said optical 25 unit except for the vicinity of said photo-detector, and said fluorescence made incident from the end portion of said opening is reflected by said reflection unit and guided into said photo-detector.

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27. The status diagnostic method of a laser-diode-pumped solid-state laser apparatus according to Claim 23, wherein

5        a plurality of said photo-detectors are disposed all around the outer periphery of said optical unit, and  
any of an axial symmetry of said laser beam and degradation of said laser diode light source is identified by comparing output from a plurality of the photo-detectors.

10      28. The status diagnostic method of a laser-diode-pumped solid-state laser apparatus according to Claim 23, wherein

15      the diameter of said opening is set smaller than the diameter of said laser medium, said medium controls a laser beam having a large divergent angle, and the divergent angle of said laser beam is thus controlled.

20      29. The status diagnostic method of a laser-diode-pumped solid-state laser apparatus according to Claim 18, wherein

25      at least one of a filter selectively attenuates light having the wavelength of said pumping light and a filter selectively transmits the wavelength of a fluorescence emission line spectrum that is not used in laser oscillation out of said fluorescence emitted from said solid-state laser medium is included on the optical path of said fluorescence reaching said photo-detector.

30. The status diagnostic method of a laser-diode-pumped solid-state laser apparatus according to Claim 18, wherein

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said transparent medium is made up of any of a material that selectively attenuates light having the wavelength of said pumping light and a material that selectively transmits a wavelength of a fluorescence 5 emission line spectrum that is not used in laser oscillation.

31. The status diagnostic method of a laser-diode-pumped solid-state laser apparatus according to Claim 18, wherein

10 said laser diode light source includes: a plurality of laser diode devices; a power source that drives a plurality of said laser diode devices in a predetermined number of groups; and controller for controlling the drive current of said power source, and said controller adjusts the drive current for each of said groups in accordance with 15 the intensity of said fluorescence detected by said photodetector.